The Stewart River placer project, west-central Yukon

***Grant W. Lowey*[1]**
Yukon Geology Program

Lowey, G.W., 2001. The Stewart River placer project, west-central Yukon. *In:* Yukon Exploration and Geology 2000, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 199-206.

ABSTRACT

The Stewart River map area (115 O&N) is the most important historic and current placer gold producing region in the Yukon. Unfortunately, the historic placer-gold deposits are becoming depleted, and more efficient mining of existing deposits and exploration for new deposits must be encouraged. Although placer deposits in the Klondike district are well described and their origin is quite well understood, placer deposits in the remaining part of the Stewart River map area have not been so well documented. The purpose of the Stewart River placer project is to describe and document the geology of known placer deposits, to interpret the formation of the placer deposits, and to relate the geology of the placer deposits to the regional surficial and bedrock geology. The objectives of the project are to aid in the exploration and mining of placer deposits by providing a comprehensive and up-to-date placer geoscience database. The utility of the placer database is that it can be used to construct placer deposit models (general summaries of given placer settings). These models then serve as predictors for future placer exploration and mining. Fieldwork for the project began in 1998 and will be completed in 2001; results of the project will be published in a final report and a resource appraisal map for placer gold.

RÉSUMÉ

La région de Stewart River (115 O et N) est la plus importante région productrice d'or placérien au Yukon, à la fois sur le plan historique et actuel. Malheureusement, les placers historiques s'épuisent, et il faut favoriser une exploitation plus efficace des gisements existants et la prospection pour de nouveaux gisements. Bien que les placers du Klondike et leurs origines sont bien connus, ceux des autres parties de la région de Stewart River ne sont pas aussi bien documentés. L'objet du projet des placers de Stewart River est de décrire et de documenter la géologie des placers connus, d'interpréter leur mode de formation, et d'établir le lien entre leur géologie et la géologie de surface et du socle rocheux de la région. L'objectif est de faciliter la prospection et l'exploitation des placers en constituant une base de données géoscientifique complètes et à jour sur les placers. La base de données sera d'autant plus utile qu'elle servira à construire des modèles de placers (résumés généraux des contextes). Ces modèles serviront ensuite à prévoir les programmes futurs de prospection et d'exploitation des placers. Les travaux de terrain ont débuté en 1998 et se termineront en 2001; les résultats du projet seront publiés dans un rapport final et portés sur une carte d'évaluation des ressources en or placérien.

[1]*glowey@gov.yk.ca*

INTRODUCTION

The Stewart River map area (115 O&N) is located in west-central Yukon between 63° and 64°N, and 138° and 141°W (Fig. 1). The map area is the most important historic and current placer-gold producing region in the Yukon. It includes the Klondike River (i.e., Bonanza, Hunker and Eldorado creeks), Indian River (i.e., Dominion, Gold Run, Sulphur, Eureka and Quartz creeks), Sixtymile River (i.e., Little Gold, Glacier, Miller, Bedrock, Matson and Fiftymile creeks), lower Stewart River (i.e., Scroggie and Barker creeks), Yukon River (i.e., Thistle, Kirkman and Frisco creeks), and White River (i.e., Moosehorn Range) drainage basin. Together, these drainage basins produced nearly 300,000 ounces of gold during 1995-97, or about 85% of the Yukon's placer-gold production (Mining Inspection Division, 1998). Unfortunately, continuous mining for nearly 100 years has almost depleted the historic placer gold producing areas, and more efficient mining of existing deposits and the exploration for new placer deposits must be encouraged.

Placer deposits in the Klondike and Indian River drainage basins have been extensively studied, including published government and consulting reports (Gleeson, 1970; Hester, 1970; Knight et al., 1994; Lowey, 1998; McConnell, 1905, 1907; Milner, 1976; Tempelman-Kluit, 1982; Tyrell, 1907, 1912) and eight university theses (Christie, 1996; Dufresne, 1987; Froese, 1997; Hoymann, 1990; Morison, 1985; Mustart, 1956; Ray, 1962; Rushton, 1991). Consequently, these deposits are well described and their origin is quite well understood. However, placer deposits in the remaining part of the Stewart River map area have not been so well documented. The available reports pertaining to placer geology for the western and southern part of the Stewart River map area include the following: the general geology of the western part of the Stewart River map area by Cockfield (1921); an outdated report on placer mining on Scroggie, Barker, Thistle and Kirkman creeks (Cairnes, 1917); a brief description of the geology of the Moosehorn Range by Morin (1977); a Masters thesis on the origin of gold in the Sixtymile area by Glasmacher (1984); a Masters thesis on the geomorphology of placers in the Sixtymile area by Hughes (1986); several government reports on the gold potential of high-level terraces in the lower Stewart River and Sixtymile River areas (Fuller, 1994, 1995); a brief report on the placer geology of Blackhills Creek (Fuller and Anderson, 1993); a report outlining the surficial geology of part of the Yukon River area south of Dawson City (Morison et al., 1998); and brief summaries of active placer mining operations by the Mining Inspection Division (1998, as well as earlier reports). In short, a comprehensive and up-to-date placer geoscience database for most of the Stewart River map area is lacking.

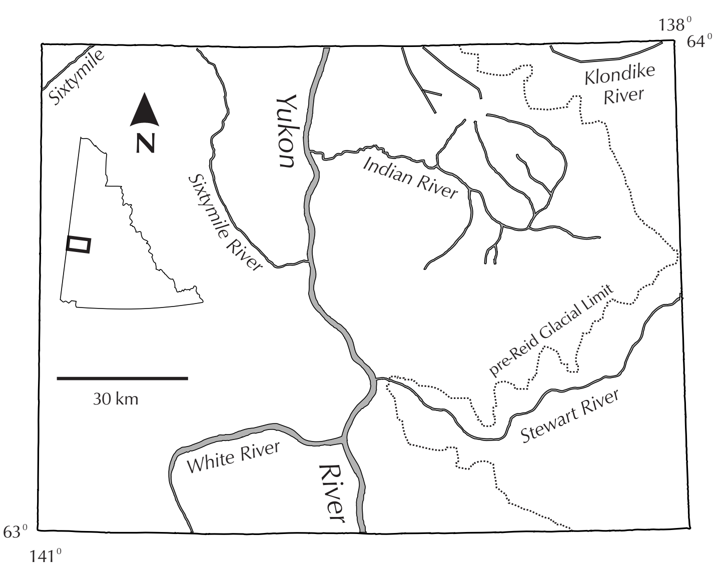

Figure 1. *Location map of the Stewart River map area (115 O&N), west-central Yukon.*

PURPOSE

The main purpose of this project is to describe and document the geology of known placer deposits in the Stewart River map area (i.e., deposit thickness, composition, texture, sedimentary structures, gold content and age). Other purposes of the project are to interpret the formation of the placer deposits, and to relate the geology of the placer deposits to the regional surficial and bedrock geology (particularly the NATMAP (National Mapping Program) surficial geology and bedrock geology mapping programs). The objective of the project is to aid in the mining and exploration of placer deposits in the Stewart River map area by providing a comprehensive and up-to-date placer geoscience database.

The utility of the placer database is that is can be used to construct placer deposit models. A placer deposit model is a general summary of a given placer deposit setting. Using a sluice box as an analogy, the placer deposit model is obtained from the database by 'sluicing away' local details, leaving behind the 'nuggets' or important features (Fig. 2). For example, important features of a placer deposit model for the Klondike area include gravel that is late Pliocene to early Pleistocene in age, quartzrich, and preserved on high- to mid-level terraces (i.e., the White Channel Gravel; Lowey, 1998). These important features then act as a norm for comparison (i.e., placer deposits from other areas can be compared and contrasted), as a framework for future observations (i.e., what types of data should be recorded from placer deposits from other areas), as a basis for interpretation (i.e., the environment of deposition and the hyrodynamics of the stream flow forming the placer deposit), and most importantly, as a predictor for future placer exploration and mining (i.e., the grade and lateral and vertical continuity of the pay streak of the placer deposit can be inferred). The placer deposit model thus serves as an ore deposit model, similar to those used in mineral exploration for lode deposits (Hodgson, 1993).

METHODS

The project mainly involves visits to active and abandoned placer mines. Fieldwork consists of placer deposit mapping, which includes constructing profiles of two-dimensional exposures of placer deposits (mostly pit walls of placer mining operations). These profiles are essentially 'vertical geologic maps' and they are constructed in much the same way. They begin with a base map — a line drawing or photo-mosaic of the pit wall; foot traverses are then made across the profile, and sedimentologic and stratigraphic observations and measurements are recorded on the base map. In addition, sedimentary structures or contacts are 'walked-out', and samples are collected for grain-size, lithological, whole-rock and geochemical analyses, as well as fossil and radiometric age-dating analysis. A three-page field report form is used to record these observations (Fig. 3), and this data is eventually entered into the Placer MINFILE database.

WORK COMPLETED

Three field seasons have been completed to date. Placer settings examined include deposits in the Klondike River drainage (i.e., Bonanza, Hunker, Last Chance, Eldorado, Gold Bottom and Bear creeks), the Indian River drainage (i.e., Dominion, Gold Run, Sulphur, Eureka, Quartz, Montana and Little Blanche creeks), the Sixtymile River drainage (i.e., Little Gold, Glacier, Miller, Bedrock, Matson, TenTenmile and Fiftymile creeks), the lower Stewart River drainage (i.e., Black Hills, Henderson, Brewer, Scroggie and Barker creeks), the Yukon River drainage (i.e., Thistle, Kirkman, Excelsior and Frisco creeks), and the White River drainage (i.e., Moosehorn Range).

WORK PLANNED

One final summer of fieldwork is planned to complete this project. During July and August, 2001, fieldwork will include visits to placer mines in the Maisy May and Henderson creek drainage basins, and due to active mining, placer deposits along Thistle, Dominion and Montana creeks will be re-examined. Placer exploration sites in the North Ladue River area will also be investigated.

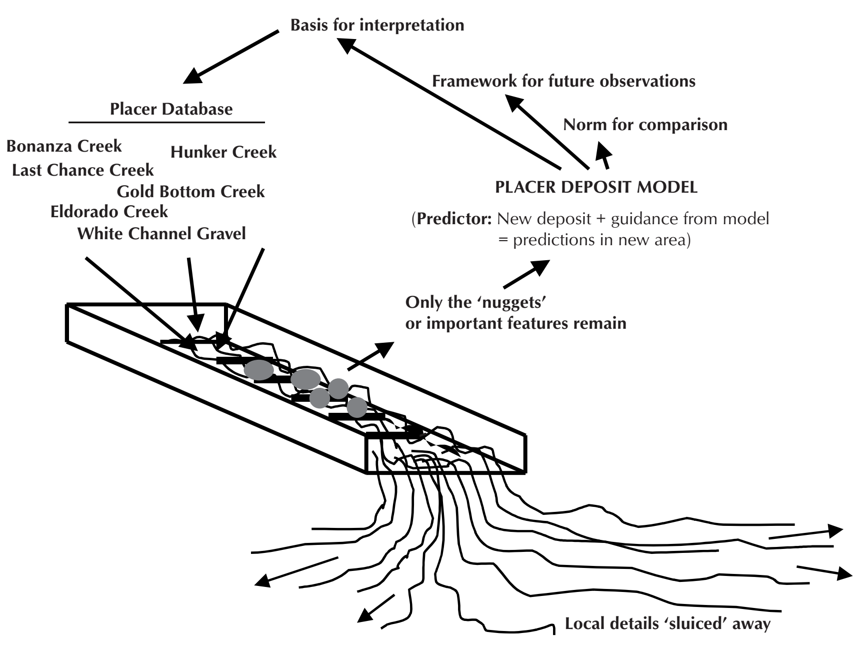

Figure 2. *Sluice box analogy of the placer deposit model.*

PROJECT HIGHLIGHT

Most of the placer gold in the Stewart River map area was deposited in a fluvial environment, and it is known that changes in the base level of a stream (i.e., the level to which a stream erodes its base; Miall, 1996) are controlled by changes in tectonics, sea level or climate. Also, changes in base level result in changes in accommodation space (i.e., the space made available for potential sediment- and placer-gold-accumulation). Very little is known about the neotectonics of the Stewart River map area, and the map area is considered too far inland to have been affected by changes in sea level. An important highlight from this project is the realization that climatic change, due to repeated cycles of glaciation related to the pre-Reid, Reid and McConnell glacial events, has had an important influence on the formation of placer gold deposits in the Stewart River map area. Climatic change, caused by orbital forcing (i.e., changes in the Earth's eccentricity, obliquity and precession), has been invoked to explain lithological cyclicity in a variety of sedimentary environments (Waterhouse, 1999; Williams et al., 1998). Placer deposits in the Stewart River map area display a cyclicity, preserved as several levels of gold-bearing gravel terraces, related to the aggradation and incision of the gravel. Vandenberghe (1993) has shown how climate-controlled variations in runoff and sediment supply, due to cycles of glacial and interglacial phases, result in cycles of stream aggradation and incision. A change from the initiation of glaciation to the maximum glacial phase

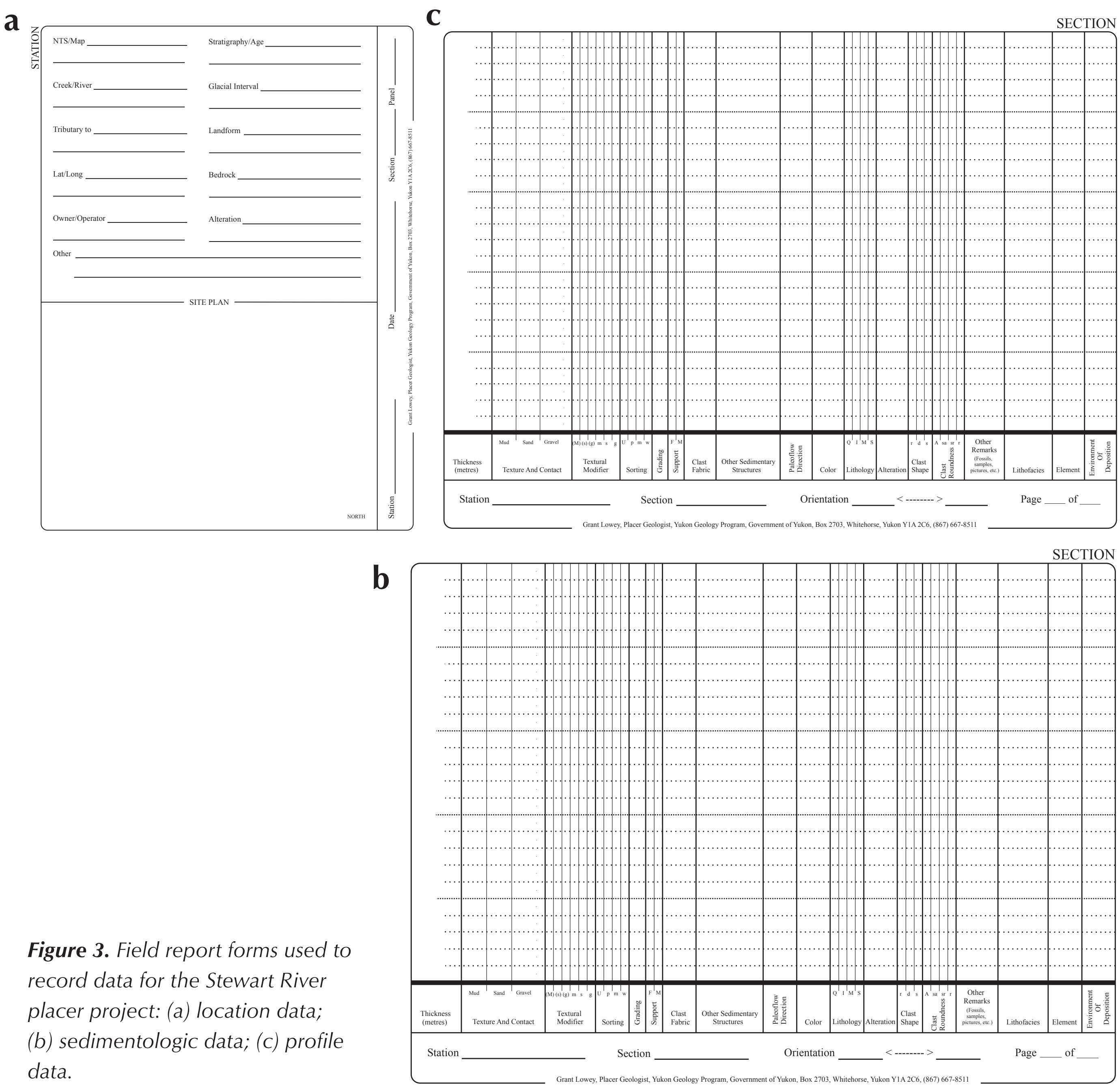

Figure 3. *Field report forms used to record data for the Stewart River placer project: (a) location data; (b) sedimentologic data; (c) profile data.*

causes a relative increase in runoff and a dramatic increase in sediment supply (as vegetation disappears and slopes become unstable), resulting in aggradation. A change from a glacial to interglacial phase causes a dramatic increase in runoff and a decrease in sediment supply (as limited amounts of vegetation reappear and slopes become stabilized), resulting in incision. For example, pre-Reid glaciation (and subsequent climatic change) in the Klondike area led to a relative increase in runoff and an increase in sediment supply, corresponding to a rise in base level and an increase in accommodation space. This resulted in aggradation or deposition of the White Channel Gravel and accompanying placer gold (Figs. 4 and 5). Conversely, deglaciation (and subsequent climatic change) in the Klondike area led to an increase in runoff and decrease in sediment supply, corresponding to a lowering of base level and a decrease in accommodation space. This resulted in incision or the erosion of the White Channel Gravel and the subsequent formation of the terraces. Climatic change related to the Reid and McConnell glacial events also produced cycles of aggradation and incision, but the resulting gravel terraces are less extensive and not as well developed as terraces composed of the White Channel Gravel.

PRODUCTS

Beginning in 1998, both oral and poster presentations were made at the Yukon Geoscience Forum (Whitehorse) and the International Gold Show (Dawson). An oral and poster presentation was also given at the CANQUA-CGRG Joint Conference (Calgary, 1999), and an abstract of that talk was published in the conference program (Lowey, 1999a). Similar presentations regarding this project are planned for 2001. In addition, yearly reports have been published in Yukon Exploration and Geology (Lowey, 1999b, 2000). The final product of this project will be a report (either Open File or Bulletin format) that describes and interprets the stratigraphy and sedimentology of the placer deposit settings. The report will include chapters on the stratigraphy of the placer deposits, the sedimentology of placer gold 'trapsites', a description of the placer settings according to drainage, and a discussion on the placer potential of the Stewart River map area. The report will also include a 'resource appraisal map for placer gold' (at 1:250 000 scale) that ranks the geologic probability for occurrence of placer gold deposits in the map area.

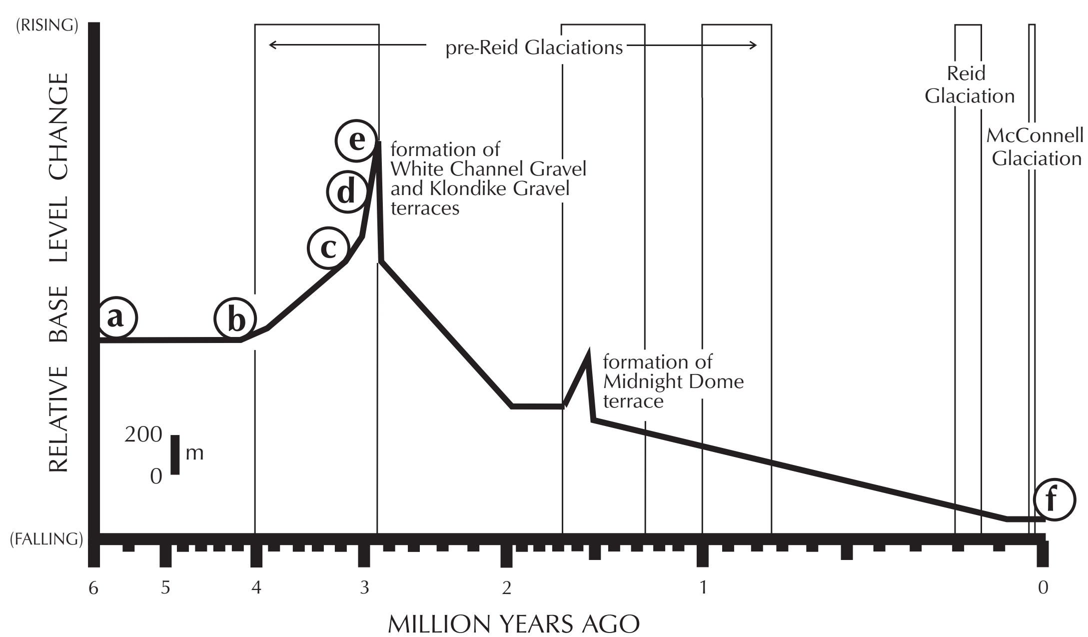

Figure 4. *Graph of base level versus time, showing the relationship between climatic change and placer formation in the Klondike area (letters refer to paleogeographic diagrams in Fig. 5).*

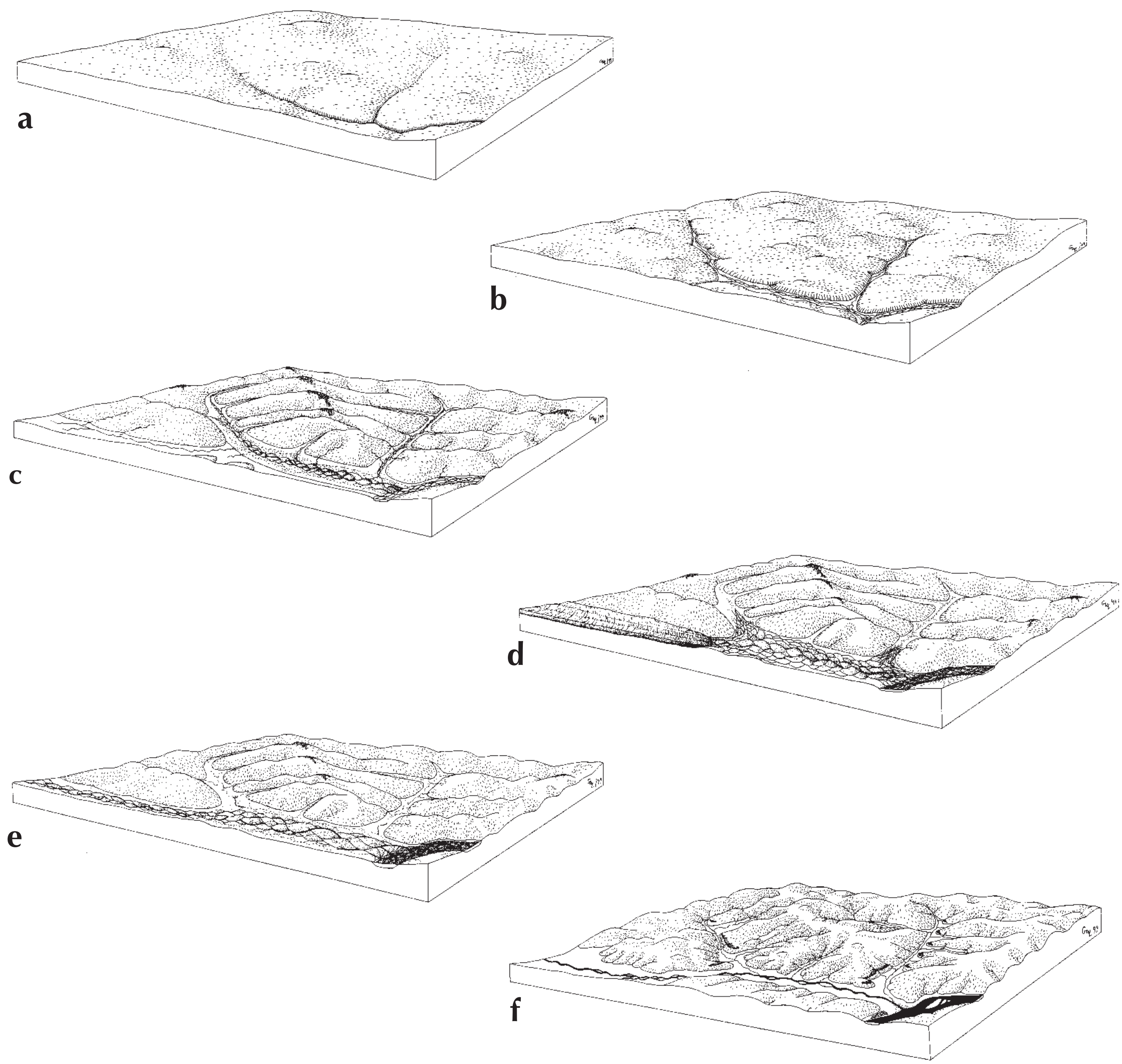

Figure 5. *Summary of the paleogeographic evolution for the Klondike area, southward view (letters refer to positions on the graph in Fig. 4): (a) ~6 million years ago (m.y.), following several million years of chemical weathering; (b) ~4 m.y., base level begins to rise due to climatic change brought about by the impending pre-Reid glaciation, and deposition of the gold-bearing White Channel Gravel begins; (c) ~3 m.y., base level continues to rise and the White Channel Gravel reaches a maximun thickness; (d) ~ 2.9 m.y., base level is still rising, the pre-Reid glaciation has reached a maximum extent, and deposition of the White Channel Gravel ends; (e) ~ 2.8 m.y., base level reaches a maximum elevation as the pre-Reid glaciation ends, resulting in the deposition of the glaciofluvial Klondike Gravel; (f) Klondike area today, showing the White Channel Gravel and Klondike Gravel terraces that formed as a result of a sudden drop in base level during pre-Reid deglaciation.*

A REQUEST

This project relies mainly on mapping existing mining pit exposures to determine the stratigraphy and sedimentology of the various placer deposit settings in the Stewart River map area. However, pit exposures provide only a two-dimensional view of the geology of the placer deposits (i.e., the height and width of gravel in the pit wall). In order to make the final report of this project as comprehensive and useful as possible to the placer exploration and mining community, it is desirable to add a 'third-dimension' to the geology (i.e., cross-sections of the placer creeks showing changes in the thickness of the gravel). These cross-sections could be constructed from drill logs. Miners are encouraged to send the author representative drill logs of mined areas, or areas being currently mined. Cross-sections of these creeks, if available, would also be useful for compilation of the final report.

ACKNOWLEDGEMENTS

I am grateful to all of the placer miners that permitted me access to their properties. Rachel Pugh and Andrew McNeil performed admirably as summer fieldwork assistants during 1999 and 2000, respectively.

REFERENCES

Cairnes, D.D., 1917. Scroggie, Barker, Thistle and Kirkman Creek, Y.T. Geological Survey of Canada, Memoir 97, 47 p.

Christie, T.M., 1996. Depositional processes of a placer gold deposit, Dominion Creek, Klondike, Yukon. Unpublished B.A.Sc. thesis, University of British Columbia, Vancouver, 212 p.

Cockfield, W.E., 1921. Sixtymile and Ladue Rivers area, Yukon. Geological Survey of Canada, Memoir 123, 60 p.

Dufresne, M.B., 1987. Origin of gold in the White Channel sediments of the Klondike region, Yukon Territory. Unpublished M.Sc. thesis, University of Alberta, Edmonton, Alberta, 181 p.

Froese, D.G., 1997. Sedimentology and paleomagnetism of Plio-Pleistocene lower Klondike valley terraces, Yukon Territory. Unpublished M.Sc. thesis, University of Calgary, Calgary, Alberta, 152 p.

Fuller, E.A., 1994. High level terraces along lower Stewart River and parts of Yukon River. *In:* Yukon Exploration and Geology 1993, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 15-28.

Fuller, E.A., 1995. High level terraces Yukon River and parts of Sixtymile River. *In:* Yukon Exploration and Geology 1994, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 34-46.

Fuller, E.A. and Anderson, F.J., 1993. Placer geology of Blackhills Creek (parts of 115 0/7 & 10) of 11. *In:* Yukon Exploration and Geology, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 33-38.

Glasmacher, U., 1984. Geology, petrography and mineralization in the Sixtymile River area, Yukon Territory, Canada. Unpublished M.Sc. thesis, Insitute of Mineralogy and Economic Geology, Aachen, Germany, 205 p.

Gleeson, C.F., 1970. Heavy mineral studies in the Klondike area, Yukon Territory. Geological Survey of Canada, Bulletin 173, 63 p.

Hester, B.W., 1970. Gold and evaluation of placer gold deposits in the Klondike area, Yukon Territory. Institute of Mining and Metallurgy, Transactions, vol. 9, p. B60-B67.

Hodgson, C.J., 1993. Uses (and abuses) of ore deposit models in mineral exploration. *In:* Ore Deposit Models II, P.A. Sheahan and M.E. Cherry (eds.), Geoscience Canada, Reprint Series 6, p. 1-14.

Hoymann, K., 1990. Gold and sulfide mineralization in the Hunker Creek area, Yukon Territory, Canada. Unpublished M.Sc. thesis, Institute for Mineralogy and the Science of Mineral Deposits, Aachen, Germany, 302 p.

Hughes, R.L., 1986. Sedimentology of the Sixtymile River placer gravels, Yukon Territory. Unpublished M.Sc. thesis, Department of Geology, University of Alberta, Edmonton, Alberta, 210 p.

Knight, J.B., Mortensen, J.K. and Morison, S.R., 1994. Shape and composition of lode and placer gold from the Klondike district, Yukon, Canada. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Bulletin 3, 142 p.

Lowey, G.W., 1998. White Channel Gravel. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1998-2 (1:100 000-scale map and marginal notes).

Lowey, G.W., 1999a. The fluvial geology of placer gold deposits in the Indian River area, west-central Yukon (abstract). *In:* CANQUA-CGRC 1999, Canadian Quaternary Association-Canadian Geomorphology Research Group, Program and Abstracts, August 23-27, 1999, University of Calgary, Calgary, Canada, p. 43-44.

Lowey, G.W., 1999b. The geology of placer gold deposits in the Indian River area, west-central Yukon. *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (ed.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 117-124.

Lowey, G.W., 2000. Glaciation, gravel and gold in the Fiftymile Creek area, west-central Yukon. *In:* Yukon Exploration and Geology 1999, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 199-209.

McConnell, R.G., 1905. Report on the Klondike gold fields. Geological Survey of Canada, Annual Report, pt. B, vol. 14, p. 1-71.

McConnell, R.G., 1907. Report on gold values in the Klondike high level gravels. Geological Survey of Canada, Report No. 979, 34 p.

Miall, A.D., 1996. The Geology of Fluvial Deposits: Sedimentary Facies, Basin Analysis, and Petroleum Geology. New York, Springer-Verlag, 582 p.

Milner, 1976. Geomorphology of the Klondike placer goldfields, Yukon Territory. Final Report, Contract OSV 5-0047, Supply and Services, Canada, 157 p.

Mining Inspection Division, 1998. Yukon Placer Industry 1995-1997. Mineral Resources Directorate, Yukon, Indian and Northern Affairs Canada, 173 p.

Morin, J.A., 1977. Geology, lode and placer gold mineralization of the Moosehorn Range, 115 N 2. *In:* Yukon Mineral Industry Report 1976, J.A. Morin, D.B. Craig and M. Marchand (eds.), Yukon Territory, Indian and Northern Affairs Canada, p. 33-54.

Morison, S.R., 1985. Sedimentology of White Channel Gravels, Klondike area, west-central Yukon. Unpublished M.Sc. thesis, University of Alberta, Edmonton, Alberta, 149 p.

Morison, S.R., Mougeot, C. and Walton, L., 1998. Surficial geology and sedimentology of Garner Creek, Ogilvie and Matson Creek map areas, western Yukon Territory (115O/13, 115O/12, 115N/9 - east half). Exploration and Geological Services Division, Yukon , Indian and Northern Affairs Canada, Open File 1998-1, 87 p.

Mustart, D.A., 1965. A spectrographic and mineralographic investigation of alluvial gold from central Yukon. Unpublished B.Sc. thesis, University of British Columbia, Vancouver, 46 p.

Ray, D.G., 1962. The mineralogy of some heavy sands, Klondike mining district, Yukon. Unpublished B.Sc. thesis, University of British Columbia, Vancouver, 43 p.

Rushton, R.W., 1991. A fluid inclusion and stable isotope study of mesothermal Au-quartz veins in the Klondike Schists. Unpublished M.Sc. thesis, University of Alberta, Edmonton, Alberta, 192 p.

Tempelman-Kluit, D.J., 1982. White Channel Gravel of the Klondike. *In:* Yukon Exploration and Geology 1981, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 74-79.

Tyrell, J.B., 1907. Concentration of gold in the Klondike. Economic Geology, vol. 2, p. 343-349.

Tyrell, J.B., 1912. The gold of the Klondike. Transactions of the Royal Society of Canada, 3rd Series, vol. 6, Section 4, p. 29-59.

Vandenberghe, J., 1993. Changing fluvial processes under changing fluvial conditions. Geomorphology, vol. 88, p. 17-28.

Waterhouse, H.K., 1999. Orbital forcing of palynofacies in the Jurassic of France and the United Kingdom. Geology, vol. 27, p. 511-514.

Williams, M., Dunkerley, D., De Deker, P., Kershaw, P. and Chappell, J., 1998. Quaternary Environments, Second Edition. Oxford University Press, Inc., New York, 329 p.